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Sir:

Transmitted herewith for filing is the patent application of

Inventor(s): YAMADA, Mamoru

For: HEAT EXCHANGING FIN AND METHOD OF MANUFACTURING THE SAME

Enclosed are:

X A specification consisting of 27 pages

X 6 sheet(s) of formal drawings

X An assignment of the invention

X Certified copy of Priority Document(s)

X Executed Declaration X Original ___ Photocopy

___ A verified statement to establish small entity status under 37 CFR 1.9 and 37 CFR 1.27

___ Preliminary Amendment

___ Information Disclosure Statement, PTO-1449 and reference(s)

___ Other ______________________________

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Respectfully submitted,

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HEAT EXCHANGING FIN AND METHOD OF MANUFACTURING THE SAME

BACKGROUND OF THE INVENTION

The present invention relates to a heat exchanging fin and a method of manufacturing the heat exchanging fin, more precisely relates to a heat exchanging fin, in which collars are formed to respectively enclose tube holes, through which heat exchanging tubes will be inserted, and the collars respectively have flares at their front ends, and a method of manufacturing the heat exchanging fin.

The heat exchanging fin, which is employed in room air conditioners, car air conditioners, etc., has: a rectangular metallic plate section, which is made of a metal, e.g., aluminum; and a plurality of collared tube holes being provided in the metallic plate section with separations and having a prescribed height.

A heat exchanger is assembled by the steps of: piling the heat exchanging fins, in which the collared tube holes are coaxially arranged; inserting heat exchanging tubes, which are made of a metallic material having high heat conductivity, e.g., copper, through the coaxial tube holes; and expanding the heat exchanging tubes, which have been inserted through the tube holes, so as to integrate the heat exchanging tubes with the heat exchanging fins.

The conventional heat exchanging fin is manufactured by the steps by a drawing manner, which is shown in Figs. 14 I - 14 VI, or a drawless manner, which is shown in Figs. 15A-15D.

In the drawing manner, shown in Figs. 14 I - 14 VI, a shallow projected section 106, which has a columnar shape or a

truncated cone shape, is formed in a thin aluminium plate section 100 (see Fig. 14 I). Diameter of the shallow projected section 106 is greater than that of the collared tube holes to be formed. Next, the diameter of the shallow projected section 106 is reduced and height thereof is gradually higher by drawing the shallow projected section 106 (see Figs. 14 II - 14 IV).

A top face of the projected section 109, which is formed by drawing the shallow projected section 106 until reaching a prescribed height, is opened and burred to make a cylindrical section 104 (see Fig. 14 V). Further, a flare 105 is formed by bending a top end of the cylindrical section 104 (see Fig. 14 VI).

In the drawless manner, shown in Figs. 15A - 15D, a base hole 101, which is enclosed by a projected part 102, is formed by boring and burring the metallic plate section 100 (see Fig. 15A). Then, diameter of the base hole 101 is made greater and the projected part 102 is squeezed until a cylindrical section 104 which has a prescribed height is formed (see Figs. 15B and 15C).

Next, the flare 105 is formed by bending the top end of the cylindrical section 104 (see Fig. 15D).

The heat exchanging fins having the collared tube holes, which include the cylindrical sections 104 and the flares 105, are formed by the manner shown in Figs. 14 I - 14 VI or Figs. 15A-15D. When the heat exchanging fins are piled, the flares 105 of one heat exchanging fin contact a bottom face of the adjacent heat exchanging fin, so that the separation between the heat exchanging fins can be defined.

In the manner shown in Figs. 14 I - 14 VI or Figs. 15A-15D, the base hole, which is bored in the top face of the projected section 109 or in the metallic plate section 100, is a circular hole. And, in the manner shown in Figs. 14 I - 14 VI or Figs. 15A-15D, the width of the flare 105, which is formed to enclose an circular edge of the top end of the cylindrical section 104, is fixed.

These days, light heat exchanging fins are required, so thickness of the metallic plate section 100 must be thinner.

On the other hand, tough heat exchanging fins are also required. Namely, the heat exchanging fins, which are not only thin but also tough, are required, so the metallic plate section 100 is made of a thin and tough metallic material.

Extensibility of the thin and tough metallic material is less than that of a thick and soft metallic material, so it is improper for the thin and tough metallic material to press and form the heat exchanging fins. When the flare 105 is formed by bending the top end of the cylindrical section 104, the flare 105 is outwardly pulled. In the case of using the thin and tough material which has the small extensibility, a crack 106 is apt to be formed in the flare 105 (see Fig. 16) because the end of the flare 105 is extremely extended.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a heat exchanging fin capable of preventing cracks from forming in the flares of the collared tube holes, even if the metallic plate section is made of the thin and tough material.

Another object of the present invention is to provide a

method of manufacturing said heat exchanging fin.

To achieve the objects, the inventor of the present invention has studied. Then, he found that forming cracks in the flares of the collared tube holes could be prevented by forming three radially extended sections as the flare.

The basic structure of the heat exchanging fin of the present invention comprises:

a metallic plate section having a plurality of tube holes;

a plurality of collars each of which is extended from an edge of each tube hole; and

a plurality of flares each of which is formed at a front end of each collar,

wherein each flare includes a plurality of radially extended sections, which are radially outwardly extended from the front end of each collar, and separation between the metallic plate section and each radially extended section is fixed.

In the heat exchanging fin, a shape of an outer edge of each flare may be formed into a polygonal shape. The polygonal shape may be a triangle, a tetragon, etc.

In the heat exchanging fin, the radially extended sections of each flare may be provided to locate their apexes with regular separations in the circumferential direction.

In the heat exchanging fin, a shape of an outer edge of each flare may be formed into a regular polygonal shape. The regular polygonal shape may be a regular triangle, a regular tetragon, etc.

In the heat exchanging fin, each flare may include a

plurality of narrow sections, which are radially outwardly extended from the front end of each collar and their width is narrower than that of the radially extended sections.

In the heat exchanging fin, the radially extended sections of each flare may be provided with regular separations in the circumferential direction.

The basic structure of the method of manufacturing the heat exchanging fin including: a metallic plate section having a plurality of tube holes; a plurality of collars each of which is extended from an edge of each tube hole; a plurality of flares having prescribed height, each flare being formed at a front end of each collar,

comprises the steps of:

forming a cylindrical section, in which higher sections and lower sections are alternately formed at a front end, along the edge of each tube hole; and

forming the flare of each collar by radially outwardly bending the higher sections of the cylindrical section.

In the method, the cylindrical section having the higher sections and the lower sections may be formed by the steps of:

forming a projected section, which is formed into a columnar or a truncated cone shape, in the metallic plate section by drawing the metallic plate section;

boring a base hole, which is formed into an elliptic or a polygonal shape, in the projected section; and

burring the base hole so as to form the cylindrical section, in which at least two higher sections are formed at the front end, along the edge of the tube hole.

In the method, the base hole may be formed into a

triangle or a tetragon.

In the method, the higher sections may be provided at the front end of the cylindrical section with regular separations in the circumferential direction.

In the method, the base hole is formed into a regular triangle or a regular tetragon.

In the method, the cylindrical section having the higher sections and the lower sections may be formed by the steps of:

boring a base hole, which is formed into an elliptic or a polygonal shape, in the metallic plate section;

burring the base hole; and

drawing a projected part, which is projected from an edge of the burred base hole, so as to form the cylindrical section, in which at least two higher sections are formed at the front end, along the edge of the tube hole.

In the method, the base hole may be formed into a triangle or a tetragon.

In the method, the higher sections may be provided at the front end of the cylindrical section with regular separations in the circumferential direction.

In the method, the flare may include a plurality of radially extended sections, which are radially outwardly extended from the front end of the collar, and a plurality of narrow sections, which are radially outwardly extended from the front end thereof and whose width is narrower than that of the radially extended sections, wherein the flare is formed by radially outwardly bending the higher sections of the cylindrical section.

As described above, a force pulling an outer edge of the

flare is greater than a force pulling an inner edge thereof when the flare, which encloses the top end of the collar with fixed width, is formed by bending the top end of the cylindrical section.

The top end of the cylindrical section has rough and hard faces, which are formed when the metallic plate section is bored and broken by a die-punch set. Thus, if the greater pulling force, which pulls the outer edge of the flare in the circumferential direction, is applied to the flare, which is formed by bending the top end of the cylindrical section, the cracks are apt to be formed in the vicinity of the outer edges of the flares.

On the other hand, in the present invention, the flare of the collar is constituted by a plurality of the radially extended sections, which are arranged at the front end of the collar with separations. With this structure, the pulling force applied to one of the radially extended sections does not influence other radially extended sections. The greater pulling force capable of pulling the outer edge of the flare can be prevented when the flare is formed at the front end of the cylindrical section by bending, so that forming the cracks in the flare can be prevented.

To manufacture the heat exchanging fins having the collared tube holes, the height of the cylindrical sections must be a prescribed height. Especially, in the conventional heat exchanging fins, the whole edge of the top end of the cylindrical section must have a prescribed height, so the cylindrical section is drawn or squeezed until the whole edge of the top end reaches the prescribed height.

On the other hand, in the present invention, the front end of the cylindrical section is uneven, namely the front end has the higher sections and the lower sections. And, the top ends of the higher sections must have a prescribed height. The whole edge of the front end of the cylindrical section need not have the prescribed height, so the heat exchanging fins can be easily manufactured.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will now be described by way of examples and with reference to the accompanying drawings, in which:

Fig. 1 is a perspective view of the heat exchanging fin of an embodiment of the present invention;

Fig. 2 is a plan view of a collared tube hole 14 of the heat exchanging fin shown in Fig. 1;

Fig. 3 is a sectional view of the collared tube hole 14 taken along a line A-A shown in Fig. 2;

Figs. 4A-4D are sectional views showing the steps of manufacturing the heat exchanging fin shown in Fig. 1;

Fig. 5 is a plan view of a base hole 26 bored in the step shown in Fig. 4B;

Fig. 6A-6D are sectional views showing the steps of manufacturing the heat exchanging fin shown in Fig. 1;

Fig. 7 is a plan view of a base hole 30 bored in the step shown in Fig. 6A;

Fig. 8 is a perspective view of the heat exchanging fin of another embodiment;

Fig. 9 is a plan view of a collared tube hole 41 of the

heat exchanging fin shown in Fig. 8;

Fig. 10A is a plan view of the base hole 26 bored in the step shown in Fig. 4B;

Fig. 10B is a plan view of the base hole 30 bored in the step shown in Fig. 6A;

Fig. 11 is a perspective view of the heat exchanging fin of another embodiment;

Fig. 12 is a plan view of a collared tube hole 52 of the heat exchanging fin shown in Fig. 11;

Fig. 13A is a plan view of the base hole 26 bored in the step shown in Fig. 4B;

Fig. 13B is a plan view of the base hole 30 bored in the step shown in Fig. 6A;

Figs. 14 I -14 VI are sectional views showing the steps of manufacturing the conventional heat exchanging fin;

Figs. 15A-15D are sectional views showing the steps of manufacturing the conventional heat exchanging fin; and

Fig. 16 is a perspective view of the collared tube hole, in which the crack is formed in the flare.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will now be described in detail with reference to the accompanying drawings.

Fig. 1 is the perspective view of the heat exchanging fin of the embodiment. The heat exchanging fin 10 shown in Fig. 1 includes: a rectangular metallic plate section 12, which is made of aluminum; and a plurality of collared tube holes 14, which are linearly arranged in the longitudinal direction of

the plate section 12. Each collared tube hole 14 has a collar 20, in which an edge of a tube hole 16 is enclosed by a flare 18.

As shown in Fig. 2, the flare 18 includes: radially extended sections 18a, which are outwardly extended a front (upper) end of the collar 20; and narrow sections 18b, whose width is narrower than that of the radially extended sections 18a. The radially extended sections 18a are provided along an outer circumferential face of the collar 20 with regular separations.

As shown in Fig. 1, the flare 18 is formed into a regular tetragon and its corners are rounded.

Note that, the shape of the flare 18 is not limited to the regular tetragon, it may be a rectangle and may have angular corners, etc.

A sectional view of the collared tube hole 14 taken along a line A-A of Fig. 2 is shown in Fig. 3. As shown in Fig. 3, The radially extended sections 18a have flat sections (upper faces of the radially extended sections 18a). When the heat exchanging fins 10 are vertically piled, the flat sections of the radially extended sections 18a contact a bottom face of another heat exchanging fin 10, which is located on the upper side so as to support said heat exchanging fin. The separation between the metallic plate section 12 and each flat section of the radially extended section 18a is fixed, so that the radially extended section 18a can stably support the upper heat exchanging fin 10, and the adjacent heat exchanging fins 10 can be separated with fixed separations.

The narrow sections 18b have no flat sections, so they

do not support another heat exchanging fin 10. Preferably, the height of the highest points of the narrow sections 18b is equal to that of the flat sections of the radially extended sections 18a. If the height of the narrow sections 18b is lower than that of the radially extended sections 18a, an outer circumferential face of the heat exchanging tubes, which are pierced through the tube holes 16 of the piled heat exchanging fins 10, are exposed. If the tubes are seen between the heat exchanging fins 10, the external appearance and hear exchangiblity are bad.

As shown in Fig. 3, the narrow sections 18b are outwardly bent with respect to an inner circumferential face of the tube hole 16, so that the heat exchanging tube can be smoothly inserted in the tube hole 15.

A method of manufacturing the heat exchanging fin 10, which includes the collared tube holes 14 formed by the drawing manner shown in Figs. 14Ⅰ-14Ⅵ, shown in Figs. 1-3 will be explained with reference to Figs. 4A-4D.

In Figs. 4A-4D, a projected section 22 shown in Fig. 4A can be formed by the steps of Figs. 14Ⅰ - 14Ⅳ, which have been explained in the drawing manner shown in Figs. 14Ⅰ - 14Ⅵ.

A base hole 26 is bored in a flat face 24 of the projected section 22, which has been formed in the step of Fig. 4A (see Fig. 4B). As shown in Fig. 5, area of the base hole 26 is smaller than that of the flat face 24 of the projected section 22, and the base hole 26 is formed into a regular tetragon whose corners are rounded.

Next, the base hole 26, which has been bored in the flat face 24 of the projected section 22, is burred so as to form a

cylindrical section 28 whose front (upper) end is zigzag formed (see Fig. 4C). In the zigzag front end of the cylindrical section 28, higher sections 28a and lower sections 28b are alternately formed, namely four higher sections 28a (or four lower sections 28b) are arranged in the circumferential direction with regular separations.

The higher sections 28a correspond to middle parts of linear edges 26a of the base hole 26 shown in Fig. 5, which has been bored in the flat face of the projected section 22; the lower sections 28b correspond to corners 26b of the base hole 26 shown in Fig. 5.

Then, the zigzag front end of the cylindrical section 28 are pressed, namely four higher sections 28a are simultaneously pressed to bend outwardly, so that four radially extended sections 18a, which are radially outwardly extended from the front end of the collar 20, are formed (see Fig. 4D). The higher sections 28a are pressed until the flat sections are formed; parts of the lower sections 28b are pressed to form the narrow sections 18b, whose width is narrower than that of the radially extended sections 18a as shown in Figs. 2 and 3. Preferably, the separation between the plate section 12 and each narrow sections 18b is equal to that between the plate section 12 and each radially extended section 18a.

In the method shown in Figs. 4A-4D, the step of boring the base hole 26, which is formed into the regular tetragon, in the flat face 24 of the projected section 22 (see Fig. 4B) and the step of burring the base hole 26 (see Fig. 4C) may be executed separately. The boring step and the burring step may

be executed simultaneously. In this case, the steps may be executed in a press machine, in which the steps are executed in a stroke of a movable die.

In the boring step in which the base hole is bored in the flat face 24 of the projected section 22 (see Fig. 4B), the corners of the tetragonal base hole 26 may be angular, and the base hole 26 may be formed into a rectangular shape.

A method of manufacturing the heat exchanging fin 10, which includes the collared tube holes 14 formed by the drawless manner shown in Figs. 15A-15D, shown in Figs. 1-3 will be explained with reference to Figs. 6A-6D.

In the drawless manner, a base hole 30 is bored in the metallic plate section 12 (see Fig. 6A). As shown in Fig. 7, the base hole 30 is formed into the regular tetragon, and its corners are rounded.

Next, the base hole 30 is burred to form a burred hole 34 whose edge is enclosed by a projected part 32 (see Fig. 6B). Then, diameter of the burred hole 34 is increased, and the projected part 32 is squeezed until an upper zigzag end of a cylindrical section 36 reaches a prescribed height (see Fig. 6C). In the upper zigzag end of the cylindrical section 36, higher sections 36a and lower sections 36b are alternately formed. Four higher sections 36a (or four lower sections 36b) are arranged in the circumferential direction of the cylindrical section 36 with regular separations.

The higher sections 36a correspond to middle parts of linear edges 30a of the base hole 30 shown in Fig. 7, which has been bored in the metallic plate section 12; the lower sections 36b correspond to corners 30b of the base hole 30

shown in Fig. 7.

Then, the zigzag front end of the cylindrical section 36 are pressed, namely four higher sections 36a are simultaneously pressed to bend outwardly, so that four radially extended sections 18a, which are radially outwardly extended from the front end of the collar 20, are formed (see Fig. 6D). The higher sections 36a are pressed until the flat sections are formed; parts of the lower sections 36b are pressed to form the narrow sections 18b, whose width is narrower than that of the radially extended sections 18a as shown in Figs. 2 and 3. Preferably, the separation between the plate section 12 and each narrow sections 18b is equal to that between the plate section 12 and each radially extended section 18a.

In the step of boring the base hole 30 in the plate section 12 (see Fig. 6A), the tetragonal base hole 30 may have angular corners, and the base hole 30 may be formed into a rectangle.

In the method shown in Figs. 6A-6D, the step of boring the base hole 30, which is formed into the regular tetragon, in the plate section 12 (see Fig. 6A) and the step of burring the base hole 30 (see Fig. 6B) may be executed separately. The boring step and the burring step may be executed simultaneously. In this case, the steps may be executed in a press machine, in which the steps are executed in a stroke of a movable die.

In the drawing manner shown in Fig. 4A-4D, the base hole 26, which is formed into the regular tetragon, is bored in the flat face 24 of the projected section 22 (see Figs. 6A-6D),

the height of the collared tube hole 14 is higher than that of a collared tube hole based on a circular base hole 27, which is indicated by a one-dot chain line shown in Fig. 5. In Fig. 5, parts "a", which are located between the tetragonal base hole 26 and the circular base hole 27 enclosing the base hole 26, will constitute the higher sections 28a of the cylindrical section 28 shown in Fig. 4C, which is formed by burring the base hole 26, so that the height of the collared tube hole 14 can be higher.

To make the flare 18, the higher sections 28a of the cylindrical section 28 are pressed and bent to form the radially extended sections 18a. So the height of the top ends of the higher sections 28a of the cylindrical section 28, from the metallic plate section 12, must be a prescribed height; the whole edge of the top end of the cylindrical section 28 need not have the prescribed height.

When four radially extended sections 18a are formed by simultaneously bending four higher sections 28a, the radially extended sections 28a are arranged along the edge of the collar 20 with separations, so the pulling force applied to one of the radially extended sections 18a does not influence other radially extended sections 18a.

By boring the regular tetragonal base hole 26 in the flat face 24 of the projected section 22, the height of the collared tube hole 14 can be higher than that of the collared tube hole based on the circular base hole 27. If the height of the collared tube hole 14 is equal to that of the collared tube hole based on the circular base hole 27, the height of the projected section 22 can be lower. Thus, the thickness of

the metallic plate section 12 may be thinner and harder than that of a metallic plate section in which the circular base holes 27 will be bored.

In the case of the collared tube hole, which is manufactured by the drawing manner shown in Figs. 14 I -14 VI, if the thickness of the aluminum plate section 12 is 0.1 mm and the diameter of the tube hole 16 is 10 mm, the height of the collar can be 2 mm or less. On the other hand, in the case of the drawing manner shown in Figs. 4A-4D, the height of the collar 20, which has the flare 18, can be 2.3 mm.

In the drawless manner shown in Figs. 6A-6D too, the parts "a", which are located between the regular tetragonal base hole 30 and a circular base hole 31 (indicated by a one-dot chain line) enclosing the base hole 30, are formed in the plate section 12, so that the parts "a" make the cylindrical section 36 shown in Fig. 6C, which is formed by burring the base the base hole 30, increasing the diameter of the burred base hole 34 and squeezing the projected part 32, higher.

To make the flare 18, the higher sections 36a of the cylindrical section 36 are pressed and bent to form the radially extended sections 18a. So the height of the top ends of the higher sections 36a of the cylindrical section 36 must be a prescribed height; the whole edge of the top end of the cylindrical section 36 need not have the prescribed height. When four radially extended sections 18a are formed by simultaneously bending four higher sections 36a, the pulling force applied to one of the radially extended sections 18a does not influence other radially extended sections 18a as

well as the drawing manner.

If the height of the collared tube hole 14 is equal to that of the collared tube hole based on the circular base hole 31, the height of the cylindrical section 36 can be lower. Thus, degree of increasing the diameter of the burred base hole 34 and squeezing the projected part 32 can be lower, so the collared tube hole 14 having the prescribed height can be formed even if the plate section 12 is made of a thin and hard material having lower extensibility.

In the above described embodiments, the external shape of the flare 18 of the collared tube hole 14 is the regular tetragonal shape. But the external shape of the flare 18 is not limited, so the external shape of the flare 18 of the collared tube hole 14 may be a regular triangle as shown in Fig. 8.

The heat exchanging fin shown in Fig. 8 includes: the rectangular metallic plate section 12, which is made of aluminum; and a plurality of the collared tube holes 41, which are linearly arranged in the longitudinal direction of the plate section 12. Each collared tube hole 41 has the collar 20, in which an edge of the tube hole 16 is enclosed by a flare 42.

As shown in Fig. 9, the flare 42 includes: radially extended sections 42a, which are outwardly extended the front (upper) end of the collar 20; and narrow sections 42b, whose width is narrower than that of the radially extended sections 42a. The radially extended sections 42a are provided along the outer circumferential face of the collar 20 with regular separations.

As shown in Fig. 8, the flare 42 is formed into a regular triangle and its corners are rounded.

Note that, the shape of the flare 42 is not limited to the regular triangle having the rounded corners, it may have angular corners and it may be a equilateral triangle, etc.

The heat exchanging fins shown in Figs. 8 and 9, which have the collared tube holes 41, can be manufactured by the method shown in Figs. 4A-4D or Figs. 6A-6D. The methods shown in Figs. 4A-4D and Figs. 6A-6D have been described, so detailed explanation will be omitted.

Note that, in the boring step (see Fig. 4B or 6A), the shape of the base hole 26 or 30 is formed into the regular triangle 43 or 44, which has the rounded corners, as shown in Fig. 10A or 10B, so that the heat exchanging fins having the collared tube holes 41, whose shape is shown in Fig. 8 or 9, can be manufactured.

The step shown in Fig. 10A corresponds to the step shown in Fig. 4B; the step shown in Fig. 10B corresponds to the step shown in Fig. 6A.

The higher sections 28a or 36a, which are shown in Fig. 4C or 6C, correspond to middle parts of linear edges 43a or 44a of the triangular base hole 43 or 44 shown in Fig. 10A or 10B.

Corners 43b or 44b of the triangular base hole 43 or 44, which is included in the circular base hole 27 or 31, will constitute the lower sections 28b or 36b of the cylindrical section 28 or 36 shown in Fig. 4C or 6C.

In Figs. 1-10B, the flares of the collared tube holes are formed into polygons, but the external shape of the flares

may be ellipse as shown in Fig. 11.

The heat exchanging fin shown in Fig. 11 includes: the rectangular metallic plate section 12, which is made of aluminum; and a plurality of the collared tube holes 51, which are linearly arranged in the longitudinal direction of the plate section 12. Each collared tube hole 51 has the collar 20, in which an edge of the tube hole 16 is enclosed by a flare 52.

As shown in Fig. 12, the flare 52 includes: radially extended sections 52a, which are outwardly extended the front end of the collar 20; and narrow sections 52b, whose width is narrower than that of the radially extended sections 52a. The radially extended sections 52a are symmetrically provided with respect to the tube hole 16.

As shown in Fig. 12, the flare 52 shown in Fig. 11 is formed into an ellepse, and the radially expanded sections 52a are expanded in the longitudinal direction of the plate section 12.

The heat exchanging fins shown in Figs. 11 and 12, which have the collared tube holes 51, can be manufactured by the method shown in Figs. 4A-4D or Figs. 6A-6D. The methods shown in Figs. 4A-4D and Figs. 6A-6D have been described, so detailed explanation will be omitted.

Note that, in the boring step (see Fig. 4B or 6A), the shape of the base hole 26 or 30 is formed into the ellipse 53 or 54 as shown in Fig. 13A or 13B, so that the heat exchanging fins having the collared tube holes 51, whose shape is shown in Fig. 11 or 12, can be manufactured.

The step shown in Fig. 13A corresponds to the step shown

in Fig. 4B; the step shown in Fig. 13B corresponds to the step shown in Fig. 6A.

The higher sections 28a or 36a, which are shown in Fig. 4C or 6C, correspond to middle parts of edges 53a or 54a, which is arranged in the direction of the line of upside, of the elliptical base hole 53 or 54 shown in Fig. 13A or 13B.

The edges 53a shown in Fig. 13A are curved edges, and the edges 54a shown in Fig. 13B are linear edges, but both edges 53a and 54a can be formed into the flares 52.

The edges 53b or 54b of the elliptical base hole 53 or 54, which is included in the circular base hole 27 or 31, will constitute the lower sections 28b or 36b of the cylindrical section 28 or 36 shown in Fig. 4C or 6C.

In the above described embodiments shown in Figs. 1, 8 and 11, the collared tube holes 14, 41 and 51 are linearly arranged in the longitudinal direction of the plate section 12, but the collared tube holes 14, 41 and 51 may be arranged in two lines or in a zigzag form.

Edges of the radially extended sections 18a, 42a and 52a, which are radially outwardly extended from the upper ends of the collars 20, may be curled toward the metallic plate sections 12. In this case, the curled parts are formed in the radially extended sections 18a, 42a and 52a; no curled parts are formed in the narrow sections 18b, 42b and 52b. With this structure, machining oil, which invades in the curled parts while press machining, can be easily removed.

As described above, in the present invention, the collared tube holes having the prescribed height can be formed in the thin and hard plate section, so that the heat

exchanging fins can be lighter.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed is:

1. A heat exchanging fin, comprising:

a metallic plate section having a plurality of tube holes;

a plurality of collars each of which is extended from an edge of each tube hole; and

a plurality of flares each of which is formed at a front end of each collar,

wherein each flare includes a plurality of radially extended sections, which are radially outwardly extended from the front end of each collar, and separation between said metallic plate section and each radially extended section is fixed.

2. The heat exchanging fin according to claim 1, wherein a shape of an outer edge of each flare is formed into a polygonal shape.

3. The heat exchanging fin according to claim 2, wherein a shape of the outer edge of each flare is formed into a triangle or a tetragon.

4. The heat exchanging fin according to claim 1, wherein the radially extended sections of each flare are provided to locate their apexes with regular separations in the circumferential direction.

5. The heat exchanging fin according to claim 4, wherein a shape of an outer edge of each flare is formed into a regular polygonal shape.

6. The heat exchanging fin according to claim 5, wherein a shape of the outer edge of each flare is formed into a regular triangle or a regular tetragon.

7. The heat exchanging fin according to claim 1, wherein each flare includes a plurality of narrow sections, which are radially outwardly extended from the front end of each collar and their width is narrower than that of the radially extended sections.

8. The heat exchanging fin according to claim 7, wherein the radially extended sections of each flare are provided with regular separations in the circumferential direction.

9. The heat exchanging fin according to claim 8, wherein a shape of an outer edge of each flare is formed into a regular polygonal shape.

10. The heat exchanging fin according to claim 9, wherein a shape of the outer edge of each flare is formed into a regular triangle or a regular tetragon.

11. A method of manufacturing a heat exchanging fin including: a metallic plate section having a plurality of

tube holes; a plurality of collars each of which is extended from an edge of each tube hole; a plurality of flares having prescribed height, each flare being formed at a front end of each collar,

comprising the steps of:

forming a cylindrical section, in which higher sections and lower sections are alternately formed at a front end, along the edge of each tube hole; and

forming the flare of each collar by radially outwardly bending the higher sections of said cylindrical section.

12. The method of manufacturing a heat exchanging fin according to claim 11,

wherein said cylindrical section having the higher sections and the lower sections is formed by the steps of:

forming a projected section, which is formed into a columnar or a truncated cone shape, in said metallic plate section by drawing said metallic plate section;

boring a base hole, which is formed into an elliptic or a polygonal shape, in said projected section; and

burring said base hole so as to form said cylindrical section, in which at least two higher sections are formed at the front end, along the edge of the tube hole.

13. The method of manufacturing a heat exchanging fin

according to claim 12,

wherein the base hole is formed into a triangle or a tetragon.

14. The method of manufacturing a heat exchanging fin according to claim 12,

wherein the higher sections are provided at the front end of said cylindrical section with regular separations in the circumferential direction.

15. The method of manufacturing a heat exchanging fin according to claim 12,

wherein the base hole is formed into a regular triangle or a regular tetragon.

16. The method of manufacturing a heat exchanging fin according to claim 11,

wherein said cylindrical section having the higher sections and the lower sections is formed by the steps of:

boring a base hole, which is formed into an elliptic or a polygonal shape, in said metallic plate section;

burring said base hole; and

drawing a projected part, which is projected from an edge of the burred base hole, so as to form said cylindrical section, in which at least two higher sections are formed at the front end, along the edge of the tube hole.

17. The method of manufacturing a heat exchanging fin according to claim 16,

wherein the base hole is formed into a triangle or a tetragon.

18. The method of manufacturing a heat exchanging fin according to claim 16,

wherein the higher sections are provided at the front end of said cylindrical section with regular separations in the circumferential direction.

19. The method of manufacturing a heat exchanging fin according to claim 16,

wherein the base hole is formed into a regular triangle or a regular tetragon.

20. The method of manufacturing a heat exchanging fin according to claim 11,

wherein said flare includes a plurality of radially extended sections, which are radially outwardly extended from the front end of said collar, and a plurality of narrow sections, which are radially outwardly extended from the front end thereof and whose width is narrower than that of said radially extended sections, and

wherein said flare is formed by radially outwardly bending the higher sections of said cylindrical section.

ABSTRACT OF DISCLOSURE

HEAT EXCHANGING FIN AND METHOD OF MANUFACTURING THE SAME

An object of the present invention is to provide a heat exchanging fin capable of preventing cracks from forming in the flares of the collared tube holes, even if the metallic plate section is made of the thin and tough material. In the heat exchanging fin, a metallic plate section has a plurality of tube holes. A plurality of collars are respectively extended from edges of the tube holes. A plurality of flares are respectively formed at front ends of the collars. Each flare includes a plurality of radially extended sections, which are radially outwardly extended from the front end of each collar, and separation between the metallic plate section and each radially extended section is fixed.

FIG.1

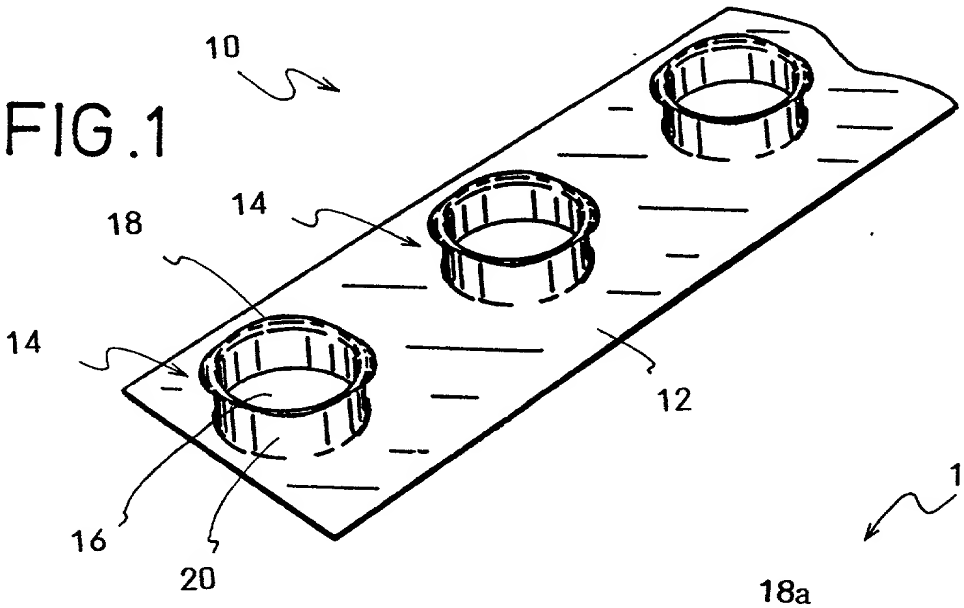


FIG.2

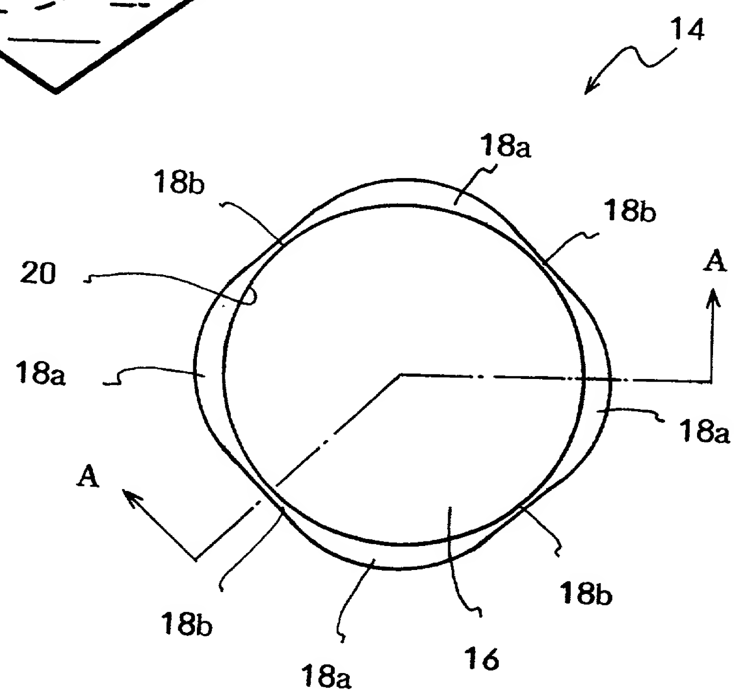


FIG.3

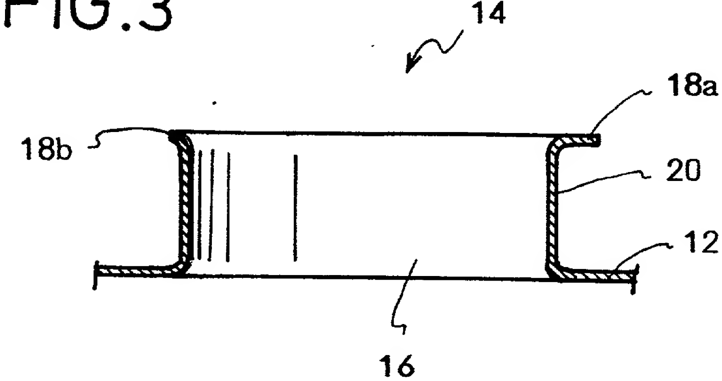


FIG.4A

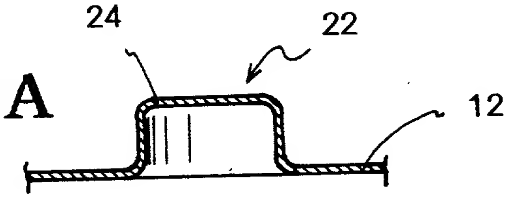


FIG.4B

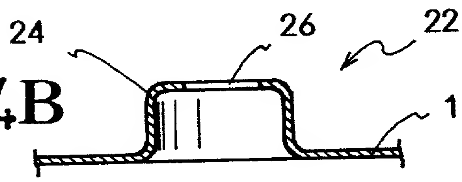


FIG.4C

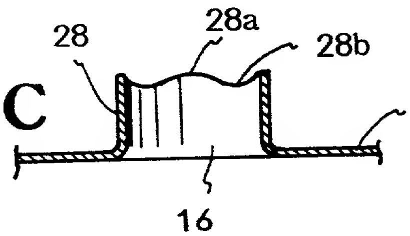


FIG.4D

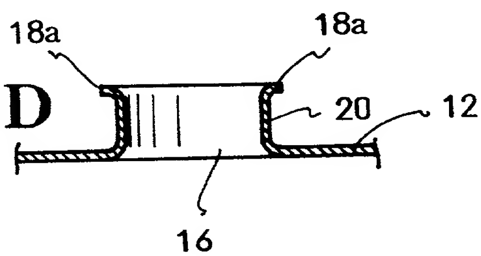


FIG.5

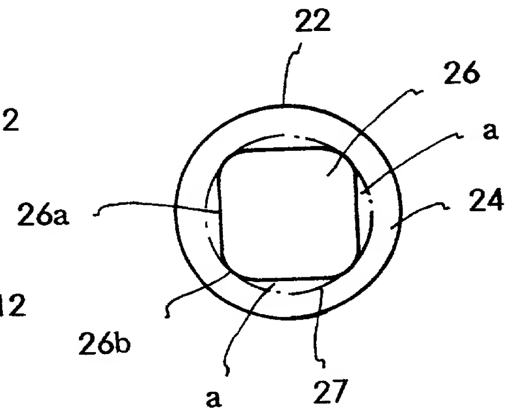


FIG.7

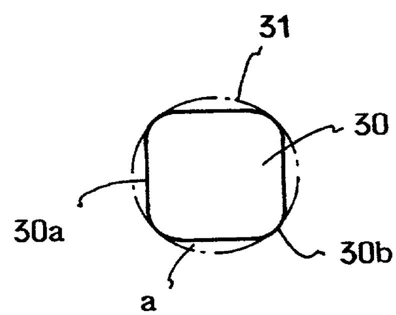


FIG.6A

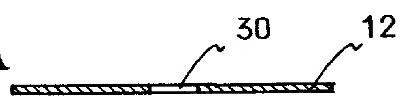


FIG.6B

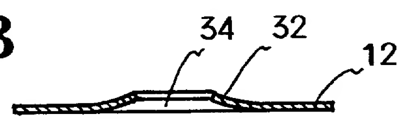


FIG.6C

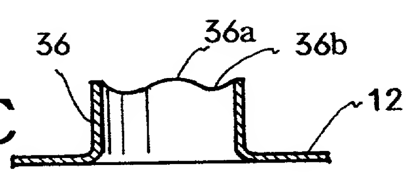


FIG.16

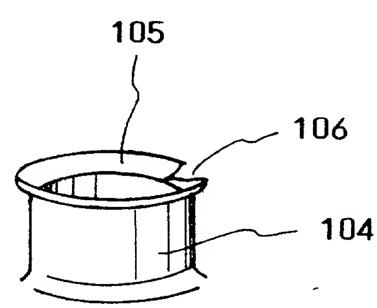
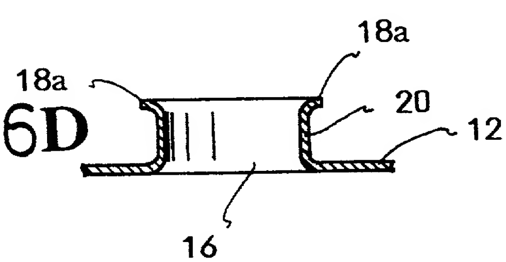


FIG.6D



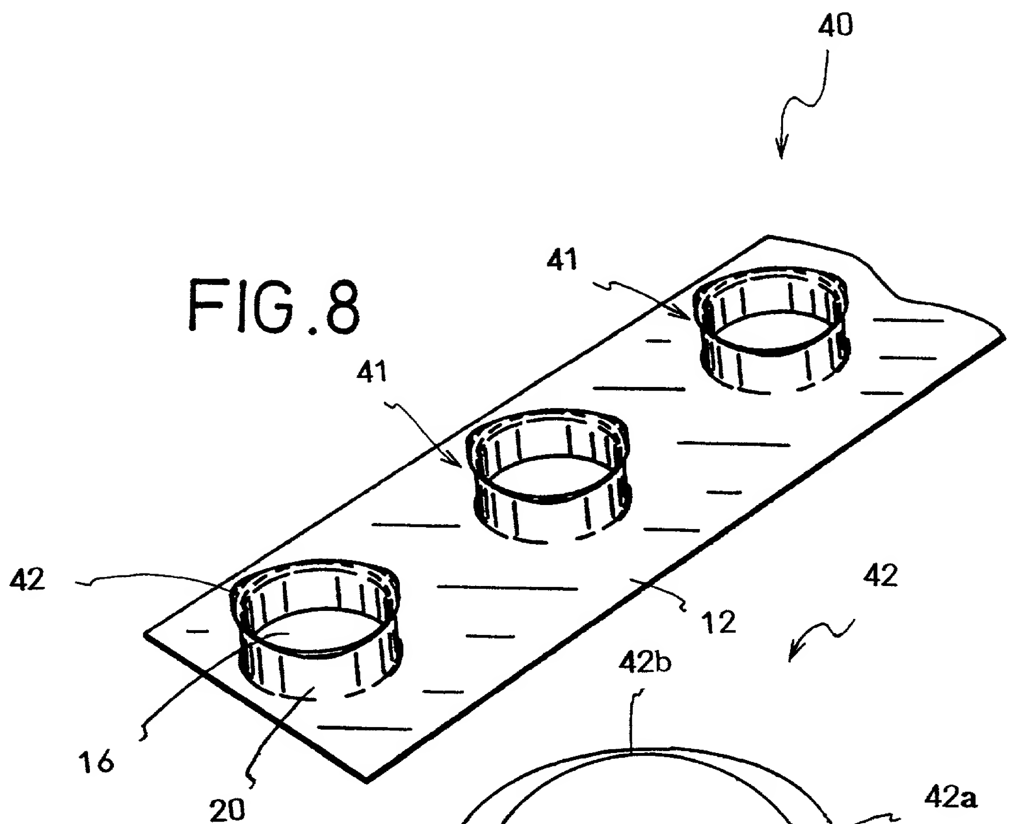


FIG.8

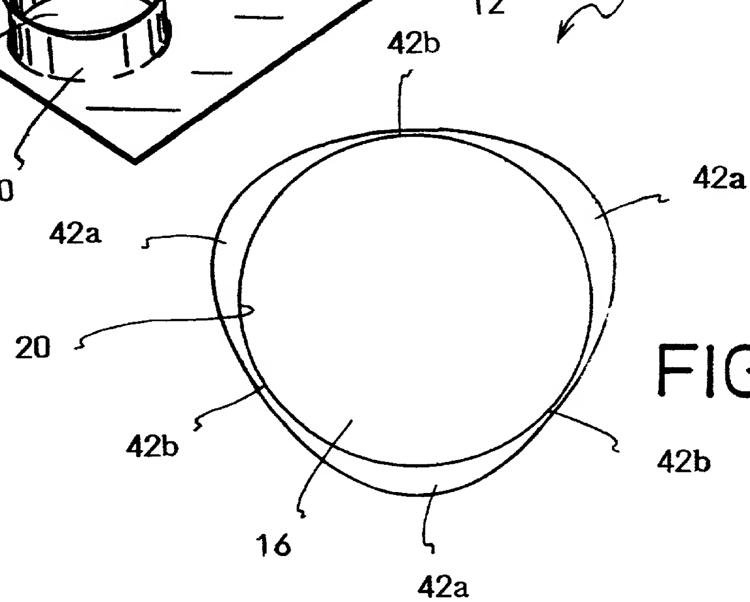


FIG.9

FIG.10A

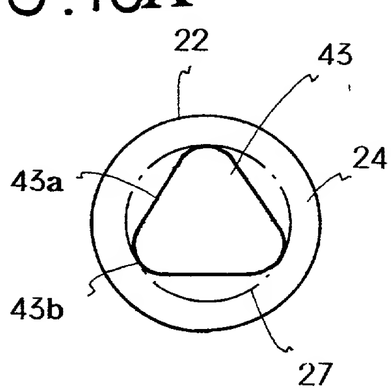


FIG.10B

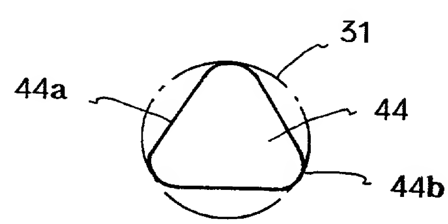


FIG.11

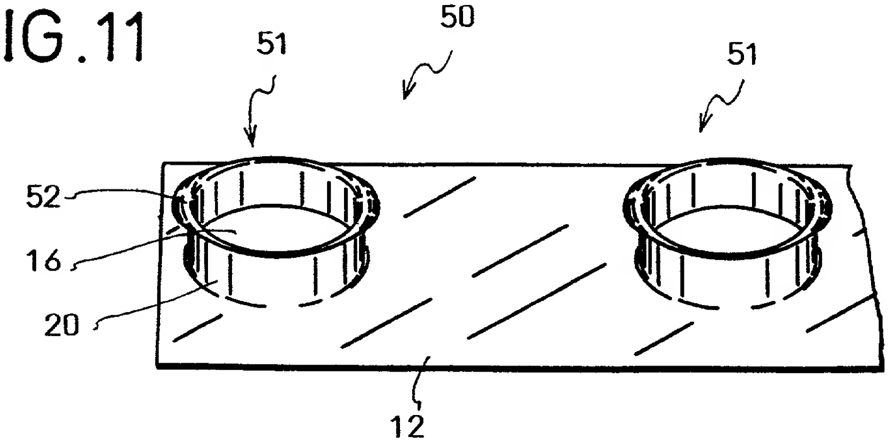


FIG.12

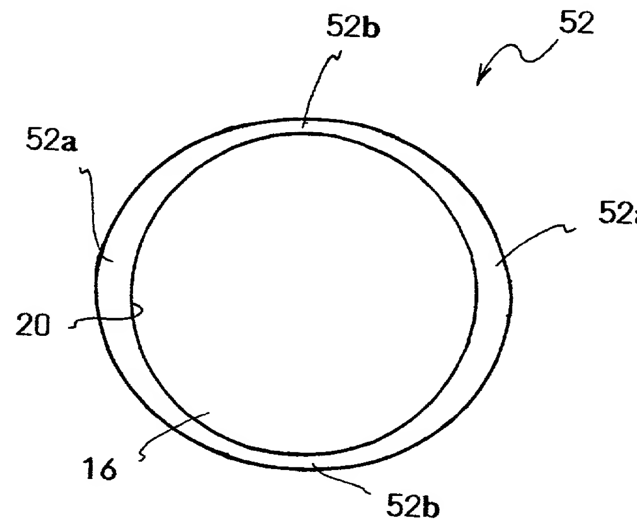


FIG.13A

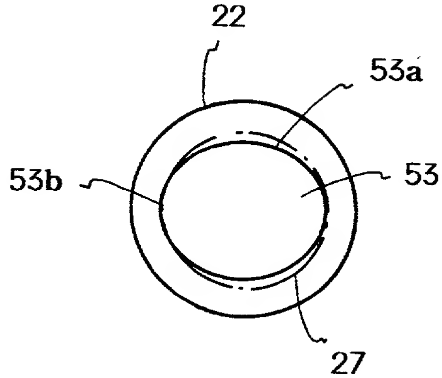


FIG.13B

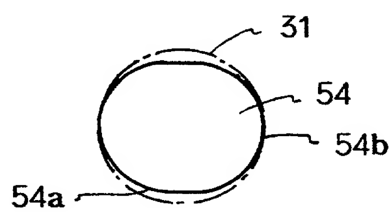


FIG.14 I
PRIOR ART

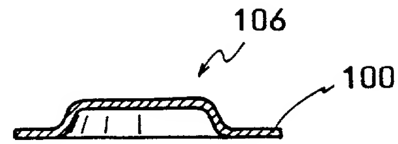


FIG.14 II
PRIOR ART

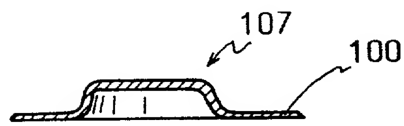


FIG.14 III
PRIOR ART

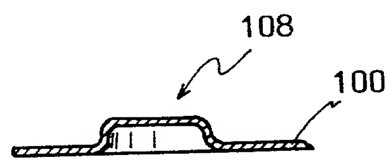


FIG.14 IV
PRIOR ART

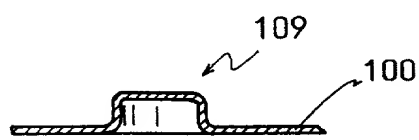


FIG.14 V
PRIOR ART

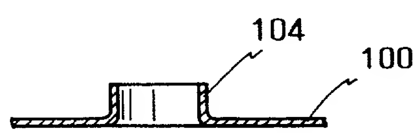


FIG.14 VI
PRIOR ART

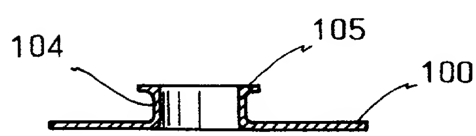


FIG.15A
PRIOR ART

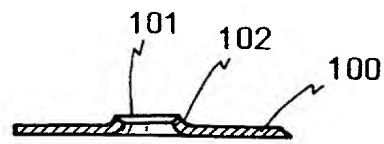


FIG.15B
PRIOR ART

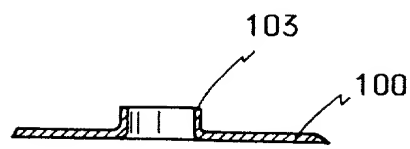


FIG.15C
PRIOR ART

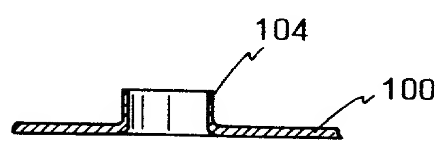
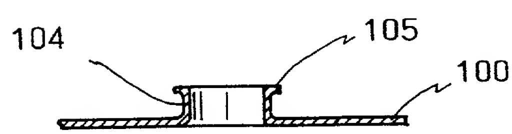


FIG.15D
PRIOR ART



BIRCH, STEWART, KOLASCH & BIRCH, LLP

COMBINED DECLARATION AND POWER OF ATTORNEY

FOR PATENT AND DESIGN APPLICATIONS

ATTORNEY DOCKET NO. 38-294P

PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING:

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one inventor is named below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Insert Title: HEAT EXCHANGING FIN AND METHOD OF MANUFACTURING THE SAME

Fill in Appropriate Information - For Use Without Specification Attached:

the specification of which is attached hereto. If not attached hereto,
the specification was filed on ______ as
United States Application Number ______; and /or

the specification was filed on ______ as PCT
International Application Number ______; and was
amended under PCT Article 19 on ______ (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (six months for designs) prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 (a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Insert Priority Information: (if appropriate)

Prior Foreign Application(s)

(Number)	(Country)	(Month/Day/Year Filed)	Priority Claimed
10-95992	Japan	April/ 8/1998	☒ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No
			☐ Yes ☐ No

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional application(s) listed below.

Insert Provisional Application(s): (if any)

(Application Number)	(Filing Date)

All Foreign Applications, if any, for any Patent or Inventor's Certificate Filed More Than 12 Months (6 Months for Designs) Prior To The Filing Date of This Application:

Insert Requested Information: (if appropriate)

Country	Application No.	Date of Filing (Month/Day/Year)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Insert Prior U.S. Application(s): (if any)

(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

I hereby appoint the following attorneys to prosecute this application and/or an international application based on this application and to transact all business in the Patent and Trademark Office connected therewith and in connection with the resulting patent based on instructions received from the entity who first sent the application papers to the attorneys identified below, unless the inventor(s) or assignee provides said attorneys with a written notice to the contrary:

Terrell C. Birch	(Reg. No. 19,382)	Raymond C. Stewart	(Reg. No. 21,066)
Joseph A. Kolasch	(Reg. No. 22,463)	James M. Slattery	(Reg. No. 28,380)
Bernard L. Sweeney	(Reg. No. 24,448)	Michael K. Mutter	(Reg. No. 29,680)
Charles Gorenstein	(Reg. No. 29,271)	Gerald M. Murphy, Jr.	(Reg. No. 28,977)
Leonard R. Svensson	(Reg. No. 30,330)	Terry L. Clark	(Reg. No. 32,644)
Andrew D. Meikle	(Reg. No. 32,868)	Marc S. Weiner	(Reg. No. 32,181)
Joe McKinney Muncy	(Reg. No. 32,334)	Andrew F. Reish	(Reg. No. 33,443)
C. Joseph Faraci	(Reg. No. 32,350)	Donald J. Daley	(Reg. No. 34,313)

Send Correspondence to: **BIRCH, STEWART, KOLASCH & BIRCH, LLP**
P.O. Box 747 • Falls Church, Virginia 22040-0747
Telephone: (703) 205-8000 • Facsimile: (703) 205-8050

PLEASE NOTE: YOU MUST COMPLETE THE FOLLOWING:

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of First or Sole Inventor:
Insert Name of Inventor
Insert Date This Document is Signed

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*
Mamoru YAMADA	Mamoru Yamada	Sep. 1, 1998

Insert Residence
Insert Citizenship

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Shibuya-ku, Tokyo, Japan	Japanese

Insert Post Office Address

POST OFFICE ADDRESS (Complete Street Address including City, State & Country) c/o Hidaka Seiki Kabushiki Kaisha of 20-3, Ebisu 3-chome, Shibuya-ku, Tokyo, Japan

Full Name of Second Inventor, if any: see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*

Residence (City, State & Country)	CITIZENSHIP

POST OFFICE ADDRESS (Complete Street Address including City, State & Country)

Full Name of Third Inventor, if any see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*

Residence (City, State & Country)	CITIZENSHIP

POST OFFICE ADDRESS (Complete Street Address including City, State & Country)

Full Name of Fourth Inventor, if any see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*

Residence (City, State & Country)	CITIZENSHIP

POST OFFICE ADDRESS (Complete Street Address including City, State & Country)

Full Name of Fifth Inventor, if any see above

GIVEN NAME FAMILY NAME	INVENTOR'S SIGNATURE	DATE*

Residence (City, State & Country)	CITIZENSHIP

POST OFFICE ADDRESS (Complete Street Address including City, State & Country)

* DATE OF SIGNATURE